Dentistry in Pet Rodents

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ABSTRACT: Incisor malocclusion as an isolated entity is uncommon in rodents but may occur following incisor trauma. Incisor malocclusion usually occurs concomitantly with premolar–molar malocclusion, which is especially common in chinchillas and guinea pigs. All dental patients should receive a comprehensive oral examination. Incisor–premolar–molar malocclusion with periodontal and endodontic disease is a disease complex of unknown origin that may include incisor malocclusion, distortion of the premolar–molar occlusal plane, sharp points or spikes, periodontal disease, periapical changes, apical elongation, oral soft tissue lesions, and maxillofacial abscess formation. The therapeutic options for this disease complex include continual occlusal adjustment of involved teeth, dietary modification, extraction of severely affected teeth, and abscess debridement. Because rodents with dental disease often have concurrent disease processes, a thorough systemic evaluation is usually indicated before initiating dental treatment. Balanced anesthetic technique with careful monitoring, attention to supportive care, and client education are important aspects of successfully treating rodents with dental disease.

Dental disease is common in pet rodents, especially in species with continuously growing teeth, and includes incisor malocclusion, which usually occurs concomitantly with premolar–molar malocclusion. All dental patients should therefore receive a comprehensive oral examination. Because rodents with dental disease often have concurrent disease processes, a thorough systemic evaluation is usually indicated before initiating dental treatment. Balanced anesthetic technique with careful monitoring, attention to supportive care, and client education are important aspects of successfully treating rodents with dental disease.

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ORAL ANATOMY

Dental formulas of the most common pet rodents are listed in Table 1 and depicted in Figures 1 through 4. Rodents are generally monophyodont (i.e., having a single set of teeth) and have only one maxillary incisor.[1] Chinchillas (*Chinchilla laniger*) and guinea pigs (*Cavia porcellus*) have a full elodont and aradicular hypsodont dentition (i.e., continuously growing and erupting ["open-rooted"] teeth with a long anatomic crown), whereas rats (*Rattus norvegicus*), hamsters (*Mesocricetus auratus*), prairie dogs (*Cynomys ludovicianus*), and most other rodents have elodont, aradicular hypsodont incisors and (anelodont) brachyodont (i.e., nongrowing, nonerupting, short-crowned, closed-rooted) premolars and molars.[2–4] The incisors are extremely long; in rats, the mandibular incisors extend ventral to all molars. The maxillary incisors and mandibular incisors in guinea pigs grow and erupt at a rate of 1.9 and 2.4 mm/wk,

Table 1. Dental Formulas of Common Pet Rodents

Species	Dental Formula
Chinchilla and guinea pig	I:1/1 C:0/0 P:1/1 M:3/3
Rat and hamster	I:1/1 C:0/0 P:0/0 M:3/3
Prairie dog	I:1/1 C:0/0 P:2/1 M:3/3

respectively.[5] The corresponding growth rates in rats are 2.1 and 2.9 mm/wk, respectively.[6]

In most rodents, except guinea pigs, the enamel of the incisors is yellow-orange.[1,3] The enamel is thicker on the facial aspect and tapers toward the lingual aspect, leading to the typical chisel wear pattern of these teeth.[7] The occlusion of rodents is anisognathous: The mandible is typically wider than the maxilla, resulting in an occlusal plane that is angled very characteristically in rodents with elodont cheek teeth (Figures 1 and 2). The occlusal plane is angled slightly in chinchillas but much more in guinea pigs. The temporomandibular joint allows a large degree of rostrocaudal movement with relatively little lateral motion.[1,2] Clinically important aspects of rodent dental anatomy, including normal radiographic appearance, have been described.[1]

Incisor–premolar–molar malocclusion is a common disease complex in chinchillas and guinea pigs.

DENTAL DISEASE

Clinical Signs

Many signs of dental disease in rodents are nonspecific. Animals with painful teeth, jaws, or oral mucosa may be reluctant to eat or unable to prehend, chew, or swallow food properly. Clients may notice that their pet is steadily losing weight, even though food bowls require replenishment, because the food is often scattered during attempts at feeding rather than eaten. Fecal pellets often become smaller because the animal is eating less, or, if the animal is completely anorectic, fecal output may cease completely. Body fur might appear unkempt because painful animals often no longer use their mouths for grooming. Some affected rodents exhibit bruxism due to discomfort. Maxillofacial abnormalities may be palpable or evident during inspection. Excessive salivation (i.e., "slobbers") is common. Palpable facial or mandibular swelling may be due to periapical pathosis or soft tissue infection and abscessation. Dental disease should be included in the differential list for any ocular or nasal discharge. Discomfort while the jaw is manipulated and inability to completely close the mouth may be present. Incisor overgrowth and/or malocclusion are often evident during preliminary visual inspection. Although dental disease in rodents is usually chronic, these patients can present on an emergency basis because of acute decompensation.[8,9]

Incisor Malocclusion

Incisor malocclusion due to a discrepancy in jaw length is uncommon in rodents. A total lack of dietary material for gnawing may result in incisor overgrowth in rodents. Incisor overgrowth may occur subsequent to loss or fracture of an opposing incisor, possibly resulting from a fall or being dropped.[10] Fracture of an incisor tooth may result in pulpal necrosis, periapical disease, and cessation of growth and eruption.

Incisor malocclusion may also be secondary to, or occur concomitantly with, premolar–molar malocclusion. Conversely, if incisor malocclusion prevents normal mastication, it may lead to premolar–molar malocclusion. Incisor malocclusion without premolar–molar abnormalities may be relatively rare, especially in older chinchillas.[4] Therefore, patients with incisor malocclusion should always receive a comprehensive oral examination.

Therapeutic options for incisor malocclusion include:

- Tooth-height reduction every 3 to 6 weeks or as needed, with appropriate dietary adjustment
- Extraction of the involved teeth

Incisor–Premolar–Molar Malocclusion with Periodontal and Endodontic Disease

Incisor–premolar–molar malocclusion with periodontal and endodontic disease occurs in rodents with a full elodont, aradicular hypsodont dentition, such as chinchillas and guinea pigs (Figure 5). Affected patients typically present with a history of noticeable weight loss (or even emaciation), ocular or nasal discharge, or maxillofacial abscessation.

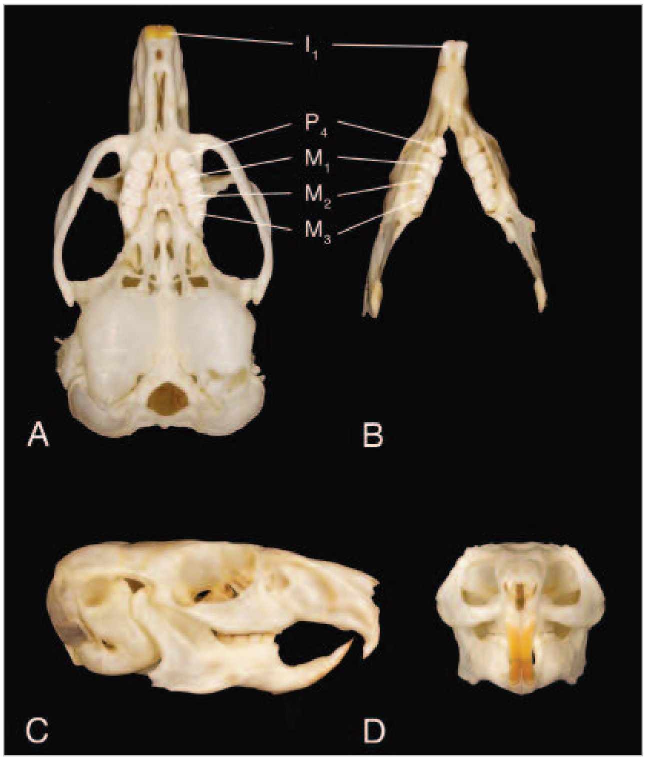

Figure 1. Dentition of the chinchilla (*C. laniger*).
A—Occlusal view of the maxillae.
B—Occlusal view of the mandibles.
C—Lateral view.
D—Frontal view illustrating the angle of the occlusal plane between the premolars and molars.
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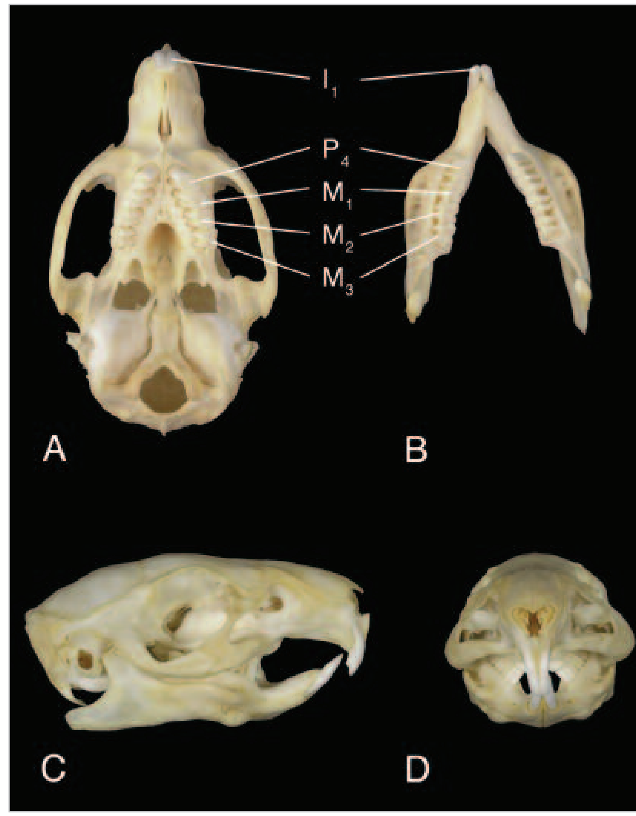


Figure 2. Dentition of the guinea pig (*C. porcellus*).
A—Occlusal view of the maxillae.
B—Occlusal view of the mandibles.
C—Lateral view.
D—Frontal view illustrating the angle of the occlusal plane between the premolars and molars.

The disease complex may include[4,7,11]:

- Incisor overgrowth or malocclusion, as already described; in addition, apical overgrowth or "root elongation" may occur
- Irregularity of the premolar–molar occlusal plane, resulting in a so-called "step-mouth," "wave-mouth," and/or sharp point or "spike" formation; sharp points typically occur on the lingual aspect of the mandibular teeth and the buccal aspect of the maxillary teeth
- Intraoral elongation of premolars and molars, with possible lingual or buccal deviation
- Periodontal disease, with increased mobility of, and pathologic diastema formation between, premolars and molars
- Premolar–molar periapical changes, with apical elongation and possible cortical perforation
- Soft tissue lesions on the oral mucosa that are associated with sharp points on premolars and molars
- Submandibular, maxillofacial, or retrobulbar abscess formation

It is unclear whether this disease complex has a genetic, dietary, or metabolic origin (or any combination thereof). The pathophysiologic relationship among orthodontic, periodontal, and endodontic lesions is equally unclear. Not all patients show all components of the complex. The clinical examination may be misleading, and a relatively minor premolar–molar malocclusion should be considered an important clinical finding. Most of the tooth structure is located below the gingival margin and is not visible during oral examination. Therefore, diagnostic imaging is an essential aspect of examining affected patients. Apical elongation is a poorly understood phenomenon. It has been found that the cheek tooth length of wild chinchillas, clini-

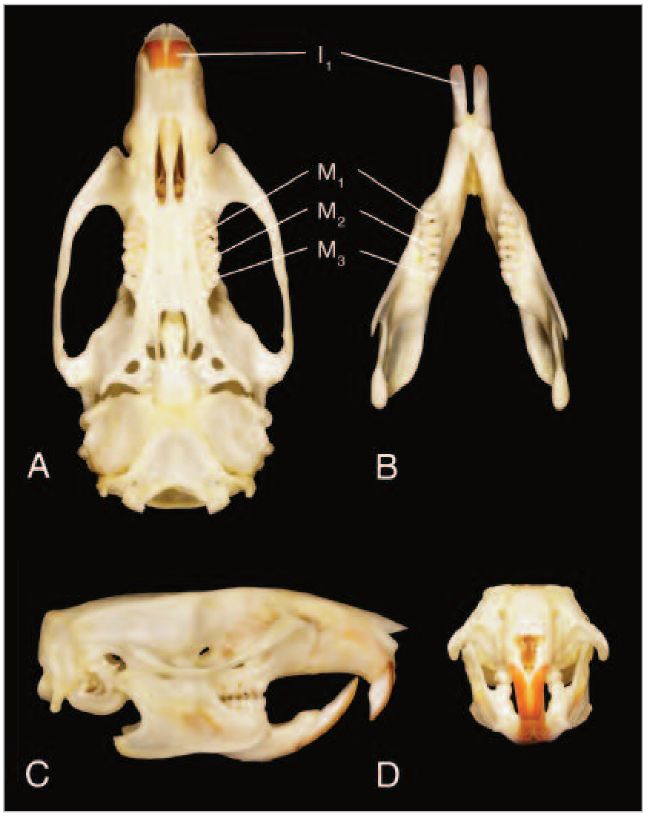


Figure 3. Dentition of the rat (*R. norvegicus*).
A—Occlusal view of the maxillae.
B—Occlusal view of the mandibles.
C—Lateral view.
D—Frontal view.

Figure 4. Dentition of the prairie dog (*C. ludovicianus*).
A—Occlusal view of the maxillae.
B—Occlusal view of the mandibles.
C—Lateral view.
D—Frontal view.

cally normal ones, and captive-bred ones with dental disease is 5.9, 7.4, and 10 mm, respectively; it was suggested that the physical form and composition of the diet are the main etiologic factors in this species.[12]

Therapeutic options for incisor–premolar–molar malocclusion with periodontal and endodontic disease may include:

- Occlusal adjustment of involved teeth
- Extraction of teeth severely affected by endodontic and/or periodontal disease
- Abscess debridement

In very severe cases, euthanasia may be considered.

Other Dental Diseases

Hypovitaminosis C in Guinea Pigs

Guinea pigs cannot synthesize their own vitamin C. Thus hypovitaminosis C may result from a deficient diet in this species, and the oral manifestations include gingival petechiation and periodontitis with increased tooth mobility.[13] Prevention and treatment consist of dietary correction.

Odontoma-like Lesions in Pet Prairie Dogs

Oral tumors appear to be very rare in pet rodents, such as chinchillas and guinea pigs.[8,9,14] The purported high incidence of odontoma formation in pet prairie dogs (*C. ludovicianus*), an emerging pet rodent, is a notable exception.[15]

An odontoma is a tumor of odontogenic origin in which both the epithelial and mesenchymal cells are well differentiated, resulting in formation of all dental tissue types.[16] An odontoma may also be considered a hamartoma (i.e., a mass resembling a tumor that represents anomalous development of tissue normally present rather than a neoplasm). Odontomas are generally rare in all species but have been diagnosed in young rodents, including rats and mice.[17]

A very specific syndrome occurring in pet prairie dogs

(*C. ludovicianus*) has recently been described.[15] Affected animals are middle-aged and typically present with upper airway obstruction.[18] The cause of the obstruction is an odontoma-like mass originating from the root of one or both maxillary incisors. An irregular globular mass of tooth density is visible via radiography.[7,15] Detailed descriptions of the histopathologic features of this disease have not been published, although it has been suggested that the mass is not an odontoma but is rather the result of the continuous apical deposition of dysplastic tooth substance.[7] It has been hypothesized that these tumors develop in reaction to mechanical trauma to the maxillary incisors, secondary to chewing on bars of a cage.[15,18] The recommended treatment is surgical removal of the mass and the associated tooth or teeth, which is technically difficult and traumatic.[15]

ANESTHESIA

Preanesthetic Evaluation

A preanesthetic evaluation is indicated for all dental procedures requiring general anesthesia. This evaluation should ideally include a general physical examination, complete blood cell count, and biochemical profile (if patient size allows). Whole-body radiography should be conducted if indicated.[19] A comprehensive evaluation is important because patients with dental disease can have concurrent diseases (e.g., pneumonia, cardiac or renal disease) or general debilitation and severe gastrointestinal (GI) stasis due to dental disease. The concurrent problems may require additional supportive care to stabilize the patient and reduce anesthetic risk. Hematologic changes associated with dental disease are generally nonspecific (e.g., anemia of chronic inflammation), but evaluating for such changes can be helpful in determining the severity of inflammation.[20]

Preanesthetic Preparation

Debilitated patients must be stabilized before anesthesia is induced, paying particular attention to hydration state, body temperature, GI tract function, nutrition, and pain management.[19,21] Variable recommendations have been made regarding fasting rodents before anesthesia and dental treatment. Because prolonged fasting can lead to hypoglycemia, small rodents should generally not be fasted for more than 1 hour. Fasting for 2 to 8 hours has been recommended in guinea pigs to reduce regurgitation and retention of food in the oropharynx.[19,22] Prolonged fasting is contraindicated in all rodent species because it can contribute to postanesthetic ileus.[19]

Figure 5. Osteologic specimen of a guinea pig showing many aspects of severe incisor–premolar–molar malocclusion with periodontal and endodontic disease.
1—Incisor malocclusion.
2—Sharp spikes and coronal elongation of the premolars and molars.
3—Excessive angulation of the occlusal plane.
4—Apical elongation with near perforation of the ventral mandibular cortex.

Anesthetic Techniques

Rodent anesthesia can be challenging because of small patient size and difficulty in intubating most patients.[22,23] The endotracheal tube can interfere with the oral examination and dental treatment in the small oral cavity of rodents. Consequently, there is much debate regarding the best method of inducing and maintaining anesthesia for dental examination and treatment. There are three main anesthetic options:

- Injectable anesthesia alone
- Inhalation anesthesia alone
- A combination of both injectable sedation/anesthesia and inhalation anesthesia

Injectable anesthesia has the advantage of not requiring a face mask, which can interfere with access to the oral

Figure 6. Use of a nose cone fashioned from a syringe case to maintain anesthesia in a guinea pig.

cavity; however, anesthetic depth can be difficult to control when relying entirely on this method. Inhalation anesthesia has the advantage of allowing rapid adjustments in anesthetic depth; however, struggling and apnea can occur during induction, and hypotension can occur if the inhalant is used alone for maintenance of a surgical plane of anesthesia.[22] Therefore, a combination of parenteral sedation and inhalation anesthesia is preferred.[24] We have found that a premedication protocol of an opioid (usually butorphanol) in combination with a benzodiazepine is satisfactory; this protocol provides both analgesia and muscle relaxation. Midazolam is the preferred benzodiazepine because it is water soluble and therefore less irritating when administered intramuscularly compared with diazepam.[25]

Anesthesia can then be induced and maintained with isoflurane or sevoflurane inhalation anesthesia. Alternatively, anesthesia can be induced with a dissociative anesthetic such as ketamine in combination with an α-adrenergic agonist such as xylazine.[19,22] Induction with agents that have a high risk of apnea, such as propofol and thiopental, is discouraged because of difficulty in intubating guinea pigs, chinchillas, hamsters, and mice.[24,26] To allow access to the oral cavity during the use of inhalation anesthetics, patients should be fitted with an appropriately sized anesthetic mask or nose cone (Figure 6); because these patients are physiologic nasal breathers, an anesthetic mask or nose cone is adequate to maintain anesthesia. Nose cones can be created using 12- or 20-ml syringe cases with a latex glove fitted over the end as a diaphragm; a proper scavenging unit at the end of the nonrebreathing circuit and a well-fitted nose cone diaphragm are necessary to limit human exposure to inhalation anesthetics.[22,27] In case of hypoventilation, supplemental oxygen should be supplied regardless of the anesthetic technique used.[22] The patient's oral cavity, especially the cheek pouches of hamsters, needs to be carefully cleaned at the onset of anesthesia. Anticholinergics such as glycopyrrolate and atropine can be used as needed to reduce respiratory secretions and bradycardia.[22]

Careful monitoring of the patient during anesthesia is essential.[28] At a minimum, body temperature, heart rate, and respiratory rate and character should be monitored. Body temperature can decrease rapidly in small patients, so external heat should be provided via heat lamps or warm-water or forced-air blankets. Heart rate can be easily monitored with a stethoscope or a Doppler ultrasound probe. We commonly place a Doppler probe over a peripheral artery in larger rodents and the heart in small rodents. Hypoventilation is common, and apnea can be fatal if the rodent is not intubated; thus respiration must be carefully monitored visually, and oxygenation can be monitored with pulse oximetry.[22] It is likely that many rodent anesthetic deaths can be avoided if careful attention is paid to patient ventilation. Anesthetic depth and head position should be adjusted as needed to maintain adequate ventilation.

A more detailed description of anesthetic techniques in rodents is beyond the scope of this article; thorough reviews of rodent anesthesia have been conducted elsewhere.[19,22]

PERIOPERATIVE SUPPORTIVE CARE

Perioperative supportive care is just as critical to a good outcome for rodents with dental disease as the dental treatment itself. Pain, hydration, nutrition, and secondary infection must be given thorough consideration.[27,29,30]

Perioperative pain management is essential and can be achieved with a combination of opioids and NSAIDs.[31] Pain may be difficult to recognize in rodents but can have significant adverse effects, such as reduced food and water intake, ileus, and delayed healing.[7] Opioids and NSAIDs can be used together as needed in the immediate postoperative period, whereas NSAIDs can be prescribed for home use. For a routine occlusal adjustment,

Table 2. Selected Antibiotics for Treating Facial Abscesses Associated with Dental Disease in Guinea Pigs and Chinchillas[39,46]

Drug	Dosage	Comments
Fluoroquinolones	—	These drugs provide broad-spectrum coverage when combined with metronidazole.
Ciprofloxacin	5–20 mg/kg PO q12–24h	—
Enrofloxacin	5–15 mg/kg PO, SC, or IM q12h	Subcutaneous injections can cause tissue necrosis. We recommend administering them diluted in at least 10 ml of saline or another electrolyte replacement fluid.
Tetracyclines		
Tetracycline	10–20 mg/kg PO q8–12h	Toxicosis has been reported in guinea pigs.[29] The lower end of the dose is recommended.
Doxycycline	2.5–5 mg/kg PO q12h	—
Sulfonamides	—	Because of poor efficacy in rabbit dental-associated abscesses, these drugs are not recommended for infections associated with dental disease.[41]
Miscellaneous		
Metronidazole	10–20 mg/kg PO q12h	Hepatotoxicity has been reported in chinchillas, so this drug should be used with caution.[47] The drug provides broad-spectrum coverage when combined with a fluoroquinolone.
Chloramphenicol	30–50 mg/kg SC, IM, or PO q8–12h	The drug can cause aplastic anemia in humans and rodents.[48,49] Owners should wear gloves when administering it. The oral form (i.e., chloramphenicol palmitate) must be compounded into a suspension by a compounding pharmacy.

a single dose of an opioid is often sufficient, whereas NSAIDs can be continued for 3 to 5 days; consideration must be given to the potential adverse effects of NSAIDs, such as GI bleeding and reduced renal blood flow, especially because little information is available on the therapeutic ranges of these drugs in guinea pigs and chinchillas.[31–33] If a major procedure (e.g., incisor extraction) has been performed, several days of opioid analgesia may be needed. Although many opioids have been used in rodents, butorphanol and buprenorphine are preferred to pure μ-agonists (e.g., morphine, oxymorphone), which increase the risk of inducing ileus.[34]

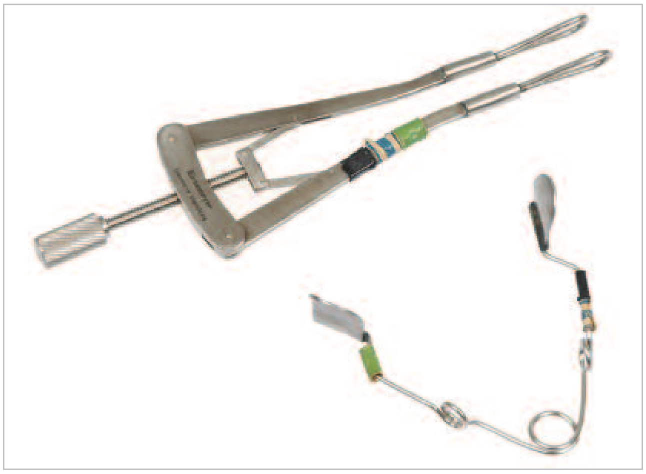
Rodents often have reduced water intake after dental procedures, especially during the early stages of treatment; therefore, hydration status must be monitored closely.[29] Although fluids can be provided intravenously and intraosseously if needed, subcutaneous fluid therapy is often sufficient; the recommended maintenance dose is 50 to 100 ml/kg/day of a balanced replacement fluid.[35,36] Using a 19- to 25-gauge butterfly catheter increases the ease of administering subcutaneous fluids and reduces the amount of restraint required.

Nutrition and GI function are essential components of the peridental assessment and treatment period. Affected patients may not be able to eat because of severe dental disease or discomfort from the dental treatment. Regardless of the cause, anorectic patients must be given nutri-

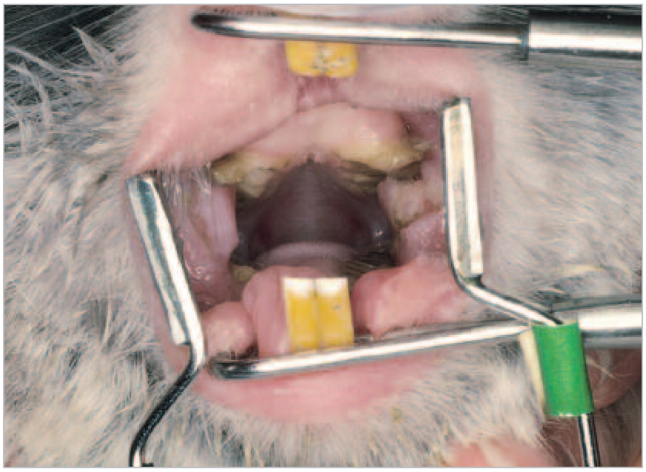
Figure 7. A lighted bivalve nasal speculum is used to examine the mouth of an unanesthetized guinea pig.

Figure 8. Oral examination of a chinchilla under general anesthesia.

Note the use of magnification, a headlamp, and an intraoral camera.



Schmidtke mouth gag *(top)* and Hollmann pouch dilator *(bottom)*.

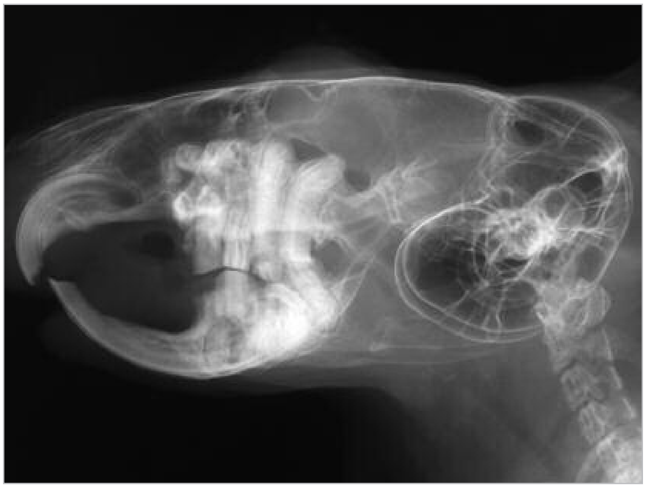


Both instruments in position.

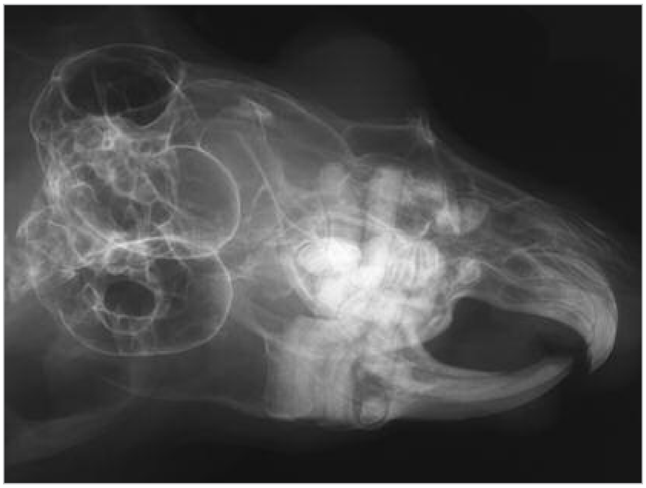
tional support.[29,37,38] For guinea pigs and chinchillas, syringe feeding a timothy hay–based, balanced herbivorous diet at 50 ml/kg/day is preferred. An option for all rodent species is feeding a gruel made of species-appropriate soaked pellets that have been processed in a blender.[36] Syringe feeding vegetable baby food is discouraged because it is not a balanced diet and does not have the necessary fiber content to promote normal GI function in some rodents. Guinea pigs on a poor diet should receive ascorbic acid supplementation.[36] Some patients may eat soaked pellets or a syringe-fed diet directly from a dish placed in their cage. Syringe feeding is often needed for 3 to 5 days after a dental treatment; however, long-term feeding may be needed in cases of severe dental disease.[38] Although feeding tubes can be placed in many rodent species, the tubes can be cumbersome to maintain and are often not needed.[37] In addition to anorexia, GI stasis commonly accompanies dental disease and its treatment. GI stasis can be managed with an appropriate diet, hydration, and pain management and prokinetic drugs such as metoclopramide (0.2 to 1 mg/kg PO, SC, or IM q12h) or cisapride (0.1 to 0.5 mg/kg PO q8–12h).[39,40]

Secondary infections must be treated. Facial abscesses are frequently associated with dental disease, but infection of oral ulcers, bacterial rhinitis, dacryocystitis due to apical elongation, and even pneumonia can occur secondary to dental disease. Appropriate antibiotic treatment should be selected based on aerobic and anaerobic culture and sensitivity testing of the abscess capsule, nasal discharge, nasolacrimal duct flush, or, if possible, a specimen obtained via ultrasound-guided fine-needle aspiration of consolidated lung lobes.[38] To our knowledge, no research has been conducted to determine the most common pathogens in rodent oral abscesses. In rabbits, these abscesses have been found to contain both aerobic and anaerobic pathogens, so antimicrobials must be chosen appropriately.[38,41] Broad-spectrum antibiotics are considered ideal, but choices are limited in many species, especially guinea pigs, chinchillas, and hamsters, because of the risk of fatal disruption of normal GI flora.[42–45] Duration of therapy depends on the site and source of infection. Infected oral ulcers may require a relatively short treatment length of 10 to 14 days, whereas maxillofacial osteomyelitis may require many months of antimicrobial therapy. Table 2[29,39,41,46–49] lists the antibiotics and dosages we have found to be most effective in treating dental-associated facial abscesses in guinea pigs and chinchillas, which are the two species that most commonly have this condition.

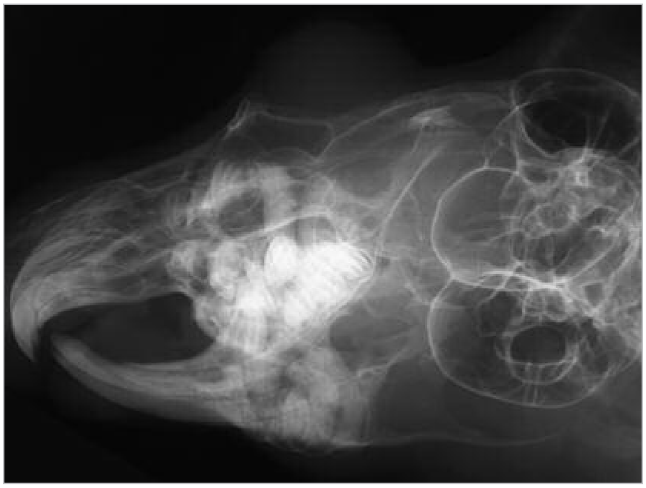
Figure 9. Radiographic views of a chinchilla with severe dental disease.



Laterolateral view.



Left lateral oblique view.



Right lateral oblique view.

Dorsoventral view.

DENTAL TECHNIQUES

Oral Examination

Rodents typically have a small mouth opening and a long and narrow oral cavity, making a complete oral examination in an awake patient nearly impossible. In addition, these species are generally easily stressed by manual restraint. A cursory examination can be performed by using an otoscope, a lighted nasal speculum (Figure 7), or a video otoscope.[10,50]

Routine use of general anesthesia is recommended for oral examination, minor procedures, and major oral surgery. Inhalation anesthesia can be administered using a face mask for oral examination and minor procedures, such as incisor crown-height reduction and abscess debridement. Extractions and major oral surgery should be performed only with proper endotracheal intubation,

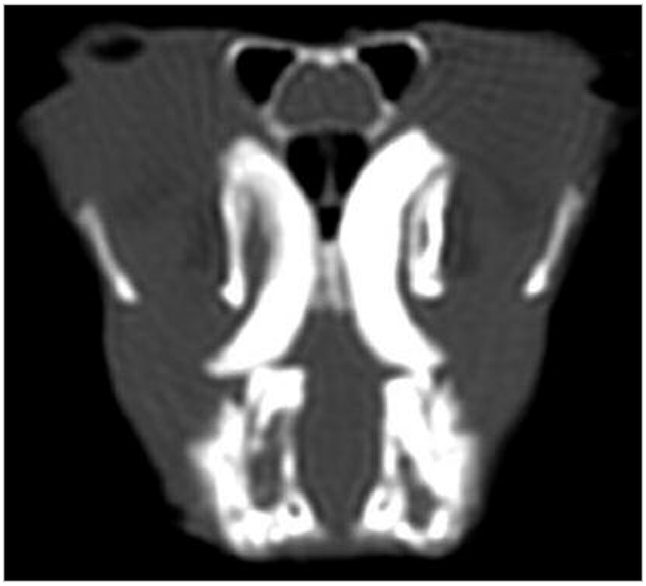


Figure 10. Computed tomography image of a chinchilla with severe dental disease.

venous access for fluid administration, and adequate anesthetic monitoring.

Oral examination is greatly facilitated by using oral speculums specifically designed for use in rabbits and rodents: One speculum should be placed between the incisor teeth, opening the mouth in a vertical plane, while a second speculum, known as a *pouch dilator*, should be placed perpendicular to the first one to open the mouth in a horizontal plane (Figure 8). Alternatively, the patient can be placed on an operating platform with an attached speculum. Good lighting, magnification, and suction facilitate the oral examination. With the oral cavity opened by means of the speculums, the tongue should be gently retracted and the dental quadrants inspected. Care should be taken not to lacerate the tongue on the mandibular incisors. Use of a small dental explorer is indicated to assess tooth mobility and increased pocket formation; a periodontal probe is usually too large to be used in small rodents.

Radiography

Radiography is an essential part of a comprehensive oral examination. Skull radiography is an extremely useful diagnostic tool in patients suspected to have malocclusion, periapical lesions, or bone disease (Figure 9). The small size of rodents and the superposition of dental quadrants make radiologic interpretation difficult. Magnified radiographic studies can be obtained using radiography units with a very small (0.1-mm) focal spot and 100-mA capability. The tube should be brought relatively close to the patient (decreasing the source object distance [SOD]) and the film further from the patient (increasing the object imaging device distance [OID]) at about the same source imaging device distance (SID) as that used for standard radiographs. The magnification is SID/SOD and can be up to three times. Alternatively, high-resolution mammography film or dental film can be used. Laterolateral, dorsoventral, and two oblique views are recommended to fully evaluate the teeth, maxillae, and mandibles. Occlusal views, although desirable, are difficult to obtain and interpret. In a recent report,[51] computed tomography (CT; Figure 10) was found to be more useful than conventional radiography in diagnosing dental problems in chinchillas, but CT adds considerably to the cost of the diagnostic workup.

Tooth-Height Reduction and Occlusal Adjustment

Tooth-Height Reduction of Incisors

Tooth-height reduction of incisors can be carried out using a cylindrical diamond bur on a high-speed handpiece (Figure 11). Care should be taken to avoid thermal damage to the pulp: A very light touch is used to avoid having to use cooling fluid; alternatively, the oropharynx can be packed if an endotracheal tube is used. A tongue depressor can be placed behind the incisors to stabilize the jaws and protect the lips and tongue. Care should be taken to restore the normal occlusal plane (incisive edge) angulation. The exposed dentin of the incisive surface of rodents has minimal permeability, and no adverse effects on the pulp should be expected.[52] If the tooth-height reduction is correctly performed, pulp exposure should not occur; however, if it does, partial pulpectomy and direct pulp capping are indicated. An intermediate restorative material should be used for filling the pulp cavity opening; harder materials like composites are not indicated because they may interfere with normal attrition.[21]

Using a cutting disk on a straight handpiece or Dremel tool (Mount Prospect, IL) is not recommended because soft tissue can easily be traumatized by these large tools. Nail trimmers and wire cutters are contraindicated because they crush the teeth, fracturing and splitting them, which in turn may cause pulp exposure. This not only is very painful but also may lead to periapical pathosis.[21,53]

Occlusal Adjustment of Premolars and Molars

Occlusal adjustment of the premolars and molars, including height reduction and smoothing sharp points and spikes, can safely be performed using a round diamond bur on a straight handpiece (Figure 12). A rabbit and rodent tongue spatula or a regular dental cement spatula can be used for retracting and protecting the oral soft tissue. Small handheld files are not very effective and tend to cause soft tissue trauma. Care should be taken to restore the normal occlusal plane angulation and to check the premolar–molar and incisor occlusion during the procedure. If a clinician is not familiar with the normal anatomy and occlusion of a rodent, it is advisable to have normal skull specimens available for reference.

Figure 11. Tooth-height reduction and restoration of the normal incisive plane angulation of mandibular incisors in a guinea pig via a cylindrical diamond bur on a high-speed handpiece. A tongue depressor has been placed behind the incisors to protect the lips and tongue.

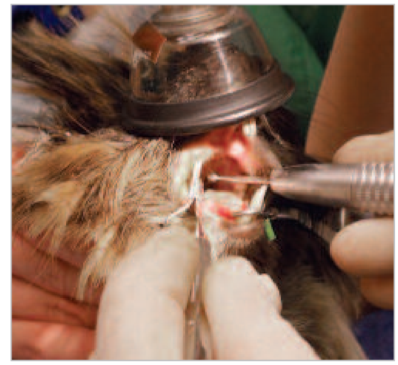


Figure 12. Occlusal adjustment of the premolars and molars in a guinea pig via a round bur on a straight handpiece. Note the use of an anesthetic mask. A regular dental cement spatula is used for retracting and protecting the oral soft tissue.

Occlusal adjustment should be performed at regular intervals as indicated by the severity of the disease. Following occlusal adjustment, some rodents, especially guinea pigs, may be unable to close their mouths.[7] This is believed to be caused by chronic stretching of the muscles of mastication associated with tooth elongation. Use of neoprene "headgear" to improve masticatory function and increase attrition has been recommended for this.[7,54]

Extraction Techniques

Incisors

Incisor extraction is complicated by the great length of the teeth involved. Very careful and patient luxation is the technique of choice. Small, sharp luxators can be used for this.[7] Alternatively, flattened and bent, suitably sized hypodermic needles can be used.[55] After the epithelial attachment has been cut with a small scalpel blade, the luxator should be carefully inserted into the periodontal space and gradually moved in an apical direction, with the clinician concentrating on, and alternating between, the mesial and distal aspect of the tooth. Some expansion of the alveolar bone plate invariably occurs, but care should be taken to limit this and avoid leverage. Once the periodontal ligament has been severed, the tooth will slide out of the alveolus along the curved growth path. This can be facilitated by using suitably sized extraction forceps. However, because of the curvature of these teeth and their trapezoid cross-section, rotational movements with the extraction forceps are not indicated. Alternating slight longitudinal traction and intrusion is appropriate in the final stage of the extraction.

Leverage, torque, and premature longitudinal traction may lead to iatrogenic tooth fracture. A retained tooth tip generally causes the tooth to regrow if the pulp remains vital. Preexisting periapical lesions cannot resolve in the presence of a retained tooth tip. It is advisable to remove all four first incisors if the treatment objective is to prevent incisor malocclusion. If a single incisor must be extracted (e.g., for a complicated crown fracture with pulp necrosis), it is generally unnecessary to extract the opposing incisor. The lateral movement of the occlusion is sufficient to cause even wear of the remaining incisors.

Perioperative supportive care, including management of pain, hydration, nutrition, and secondary infection, is crucial for a good outcome in rodents with dental disease.

Premolars and Molars

Extraction of aradicular hypsodont premolars and molars is difficult because of the size of the embedded portion of the teeth, the limited access, and the close proximity of the teeth. The bone plate separating the alveoli from the nasal cavity and orbit and the mandibular cortex overlying the alveoli are very thin, making iatrogenic damage easily possible, especially if bone lysis is present as a result of dental disease. Various techniques have been described for extracting premolars and molars[56]:

- The extraoral surgical approach (which is similar to repulsion in horses)
- The buccotomy approach (incising the cheek to gain access)
- The intraoral nonsurgical technique

The intraoral nonsurgical technique requires considerable skill and patience but is less traumatic. It must be emphasized that extraction of aradicular hypsodont teeth not only is technically difficult but also requires considerable anesthetic and nursing care support, which may make referral a better option.

RECOMMENDATIONS TO CLIENTS

Clients must be counseled on managing pets with dental disease. In cases of mild disease, encouraging the pet to eat an appropriate diet can reduce progression of dental disease.[7,9] For example, converting guinea pigs and chinchillas to a primarily timothy hay diet rather than a primarily pelleted diet can encourage increased chewing and appropriate attrition of the teeth.[57] In more severe cases, a return to a normal diet may not be possible and all that can be done is to find a balanced diet that affected animals can eat, such as soaked pellets and formulated syringe-feeding diets. Clients must also be taught what clinical signs to watch for as indicators that their pet is having problems with its teeth, such as dropping food, reduced appetite, smaller fecal pellets, and ptyalism. Clients must be educated about the chronic nature of dental disease in many rodent patients, especially guinea pigs and chinchillas, because education early in the course of treatment can prevent frustration later when the pet must be returned for treatment every 4 to 12 weeks for the rest of its life.

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ARTICLE #4 CE TEST

CE

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1. The occlusion of the chinchilla (*C. laniger*) is anisognathous, with the

a. maxillary arch being wider than the mandibular arch and considerable rostrocaudal movement.
b. mandibular arch being wider than the maxillary arch and considerable rostrocaudal movement.
c. maxillary arch being wider than the mandibular arch and considerable laterolateral movement.
d. mandibular arch being wider than the maxillary arch and considerable laterolateral movement.

2. The guinea pig (*C. porcellus*) has

a. elodont and aradicular hypsodont incisors and brachyodont premolars and molars.
b. a full elodont and aradicular hypsodont dentition.
c. a full anelodont and brachyodont dentition.
d. elodont and aradicular hypsodont incisors and premolars and a single anelodont brachyodont molar.

3. Incisor-height reduction is preferably carried out with

a. guillotine-type nail trimmers.
b. tungsten-tipped wire cutters.
c. a cylindrical diamond bur on a high-speed handpiece.
d. a cutting disk on a Dremel tool.

4. Odontoma-like masses may occur at the roots of the maxillary incisors of

a. hamsters (*M. auratus*).
b. rats (*R. norvegicus*).
c. guinea pigs (*C. porcellus*).
d. prairie dogs (*C. ludovicianus*).

5. Premolar–molar malocclusion is common in

a. chinchillas (*C. laniger*) and hamsters (*M. auratus*).
b. rats (*R. norvegicus*) and guinea pigs (*C. porcellus*).
c. rats (*R. norvegicus*) and hamsters (*M. auratus*).
d. chinchillas (*C. laniger*) and guinea pigs (*C. porcellus*).

6. Why is midazolam preferred over diazepam as an intramuscularly administered predental sedative?

a. Midazolam is more cost-effective than diazepam.
b. Midazolam is less potent than diazepam.
c. Midazolam is water soluble and therefore leads to less tissue irritation than does diazepam.
d. Midazolam causes fewer side effects than does diazepam.

7. Which food is recommended for syringe feeding anorectic guinea pigs and chinchillas with dental disease?

a. a variety of vegetable baby foods, with a small amount of fruit baby food mixed in to increase palatability
b. a timothy hay–based, balanced herbivorous diet designed for syringe feeding
c. a high-calorie, low-volume dietary supplement designed for anorectic dogs and cats
d. a slurry of vegetable baby food and sugar–electrolyte replacement solution because this provides nutrition and hydration

8. Before anesthesia and dental treatment, small rodents should be fasted

a. no longer than 1 hour to avoid hypoglycemia.
b. at least 2 hours so that the oral cavity will be free of food.
c. 4 to 6 hours to reduce the risk of vomiting.
d. at least 8 hours but no more than 10 hours.

9. Which statement regarding rodents with severe dental disease is true?

a. Severe incisor–premolar–molar malocclusion must be treated immediately via occlusal adjustment, regardless of the patient's general status, because this condition often prevents affected animals from eating.
b. Because it is unusual for rodents with dental disease to have concurrent problems, a thorough preanesthetic evaluation is generally not worth the expense to the client or risk to the patient.
c. Because most rodent patients are not intubated during anesthesia, it is essential that their respiratory rate and character be monitored constantly.
d. Incisor–premolar–molar malocclusion in guinea pigs and chinchillas can usually be completely resolved within one to two hospital visits.

10. Which statement regarding perioperative pain management in rodents is true?

a. Perioperative pain management is not indicated because rodents are extremely tolerant of pain.
b. Pure μ-agonists such as morphine and oxymorphone are the preferred opioid analgesics in rodents.
c. NSAIDs should be used only for the first day after a dental procedure because they have an increased risk of causing GI bleeding in rodents compared with other species.
d. A combination of opioids and NSAIDs can provide the most effective pain management protocol.